City of Seattle Executive Services Department
Personnel Division

MEMORANDUM

DATE: January 19, 2001

TO: Chief Schultz, Fire Department Safety Officer

FROM: Bill Budd, CIH, Citywide Safety

SUBJECT: Air Quality Monitoring at Station 31

Station 31 is a 2 story brick building built approximately 30 years ago. It is location at 1319 N. Northgate Way. I monitored for a number of indoor air quality parameters including carbon monoxide, carbon dioxide, temperature, and relative humidity using a TSI Q-Trak. I monitored for airborne particulate (PM4.5) using a TSI Dust Trak. On November 14, 2000, I collected samples for volatile organic solvents in sleeping quarters on the second floor from 9:30 a.m. to 3:30 p.m. On November 14, I also collected screening level samples for mold spores outside on the deck near the kitchen area and in the sleeping quarters.

Ventilation System/Building Observations

The only ventilation system is the exhaust vents for the bathrooms and kitchen. The heating an closed loop hot water coils system. There were vehicle exhaust hoses in the engine bay.

The dust levels did not seem to be particularly high in the facility. In the sleeping quarters/locker room area there were area fans on at all times. There was some dust on the tops of the locker, but the amount of dust did not seem excessive.

There appear to be some ongoing water leaks in the brick structure and some evidence of past leaking. There is not a musty smell. Apparently there have been attempts to seal the leaks in the wall with sealants.

In the basement, there is an area with exposed soil. Some fire fighters expressed concern that there may be radon coming from this area.

Indoor Air Quality and Air Quality Standards

Carbon monoxide is a good indicator for vehicle exhaust. The National Ambient Air Quality Standard (NAAQS) for carbon monoxide is 9 parts per million (ppm) for an 8 hour time weighted average and 35 ppm for a 1 hour average. The NAAQS is set to protect the most sensitive people in our population and regulates the outside air that is used to provide “fresh” for the indoor air environment. People in the process of breathing generate carbon dioxide. Our exhalation contains about 40,000 ppm carbon dioxide. In indoor air quality investigations, the carbon dioxide is used to indicate whether or not there is sufficient outside air being brought into the occupied space. One thousand parts per million is the upper level for acceptable indoor air quality. Temperature and relative humidity are comfort factors. Generally the temperature should remain within the 68 F to 80 F range and the relative humidity (RH) should range from 30% to 50%. The NAAQS for particles less than 10 microns (PM10) in size is 0.050

milligrams per cubic meter (mg/m3) for an annual average and 0.150 mg/m3 for a 24 hour average. One micron is 1 one millionth of a meter. The NAAQS for particles less than 2.5 microns (PM2.5) in size is 0.015 milligrams per cubic meter (mg/m3) for an annual average and 0.065 mg/m3 for a 24-hour average. The ratio of PM2.5 to PM10 ratio might range from 0.5 to 0.8 for an indoor office environment. There is also a worker exposure standard (a permissible exposure limit or PEL) for respirable particulate (PM4.5) at 5.0 mg/m3.

Results and Discussion

The measured pollutant concentrations were all below WISHA worker health standards (PEL, permissible exposure limit), but the carbon dioxide and the 4.5 um particulate were relatively high when compared to indoor air quality standard and to ambient air quality standards. The volatile organic concentrations are also higher than would be expected in an indoor office environment.

The carbon dioxide levels averaged over 1000 ppm, which is the upper range for a good indoor office environment. The highest concentrations were in the morning. I assume that there are a number of individuals sleeping in the room and that the windows remain closed. It is likely that at night the sleeping quarter on the second floor are positive pressure to the outside (based on a temperature differential). The maximum carbon dioxide concentration was 2572 ppm. If this was sustained for an 8-hour period, it would be approximately ½ the permissible exposure level for carbon dioxide.

The 4.5micron particulate levels averaged approximately 0.048 milligrams per cubic meter. This is above the annual standard but less than the 24 hour NAAQS for PM 2.5. The PM2.5 would be a subset of the 4.5micron particulate, i.e., only a portion of the PM 4.5 particulate is PM2.5. The total PM4.5 is slightly below the American Conference of Governmental Industrial Hygienists' Threshold Limit Value for diesel exhaust, which is 0.05 mg/m3 (< 1 micron).

The carbon monoxide concentration averaged 2 parts per million with a range of 0 to 7 ppm. This suggests that there is not a large infusion of vehicle exhaust or a lack of ventilation for the boiler in the basement.

The relative humidity averaged 28.7% and 53% and averaged 39.9% from November 14 to November 25, 2000. If the relative humidity rises above 50%, concerns about increase growth of molds and increase in dust mite populations. Below 30%, there are a concern about dry eyes and possibly upper respiratory tract irritation. Condensing surfaces are also a potential source of molds (e.g. cold exterior wall).

The temperature averaged 69.1 F with a range of 61.7 F to 76.5 F. The temperature fluctuated considerably.

While we might expect indoor air quality complaints at these volatile organic compound concentrations, the solvents or volatile organic compound were at least 100 times lower than worker safety levels (see Table 3). The sources of the solvents are unknown but it is likely that

there are coming from product used in the station. Methylene chloride was present at 0.063 ppm and petroleum distillates at 0.167 ppm. These are almost certainly is coming from some products used at the station.

The mold levels were about 15% of the outdoor concentrations. The only different species that was found inside but not outside was a small amount of Penicillium/Aspergillus.

Conclusions

The building is poorly ventilated as evidenced by the high carbon dioxide levels in the mornings. These levels might be similar to household where there is no mechanical ventilation, but are much higher than is generally accepted in office environments.

Although there appear to be leaks in the facility, there does not appear to be a high level of mold spores (about 1/6 the levels of outside), but this should be monitored. The low level of Penicillium/Aspergillus may indicate an indoor source of mold.

The relatively high PM 4.5 particulate might have been due to the high air velocities in the room due to area fans. In addition the outside air quality at that time was not good so it might have simply followed outdoor air. The levels were less than the 24 hour ambient air quality standard but higher than the annual ambient air quality standard for PM2.5. They were less than 1/10 the PEL.

It is unlikely that the diesel particulate would be above the proposed ACGIH TLV levels of 0.05 mg/m3 because the respirable particulate less than 0.05 ug/m3 and much of that mass will likely be in the 1 – 4.5 micron diameter. Over 90% of diesel particulate is likely to be below 1 um, whereas I was measuring up to 4.5 microns. .

I will conduct long term monitoring for radon in the basement area. It is unlikely that fire fighters at the station would have a significant exposure.

Recommendations

Always use the vehicle exhaust system in the engine bay to minimize exposure to diesel exhaust particulate.

Find the source of the methylene chloride and evaluate the need for the continued use of the product.

Increase ventilation in the sleeping quarters by opening a window in the room. If the air flow out the window from the quarters, provide make up air by opening a 1st floor window to the outside (to prevent the makeup air coming from the engine bay).

Consider installing a makeup air unit that would supply and condition outdoor air. This should have sufficient capacity to maintain positive pressure in the office/living quarter in relation to the engine bay.

In situations where the air exchange is relatively low and there is a desire to further lower the respirable particulate level, a HEPA area filter could be considered.

Continue to search for and correct any leaks. There could be ongoing leaks in the facility, which could be the source for the Penicillium/Aspergillis within the station.

Table 1: Levels of airborne dust and CO measured in the sleeping quarters at Fire Station 31 compared to the national ambient air quality standards.

Pollutant Concentrations		**Standards**			
Pollutants	**Concentration Measured Communication Center**	**NAAQS[1] Annual Average** mg/m3	**NAAQS 24 hour average** mg/m3	**NAAQS 1 hour average**	**PEL[2] 8 hour average (workplace)**
Particles < 4. 5 um ($PM_{4.5}$) Average) (11/17/2000– 11/28/2000)	0.047mg/m3	0.050 for PM_{10} 0.015 for $PM_{2.5}$	0.150 for PM_{10} 0.065 for $PM_{2.5}$		5 mg/m3
(Range)	(0.006 – 1.050)				
($PM_{4.5}$) Average) (11/14/2000– 11/17/2000)	0.048 mg/m3				
(Range)	(0.019 – 0.167)				
			NAAQS 24 hour average	**NAAQS 1 hour average**	**PEL 8 hour average**
Carbon Monoxide Average 11/14/99 – 11/25/00	2 ppm		9 ppm	35 ppm	35 ppm
Range 11/14/99 – 11/25/00	0 – 7 ppm		9 ppm	35 ppm	35 ppm

[1] NAAQS is National Ambient Air Quality Standard
[2] PEL is Permissible Exposure Limit

Table 2: Levels of CO2, RH, and Temperature measured at Station 31 compared to ambient air and occupational standards.

			ASHRAE[3] (IAQ guideline)		PEL 8 hour average
Carbon Dioxide Average 11/14/00 – 11/25/00	1032 ppm		1000 ppm		5000 ppm
Range 11/14/00 – 11/25/00	454 – 2572 ppm		1000 ppm		5000 ppm
			ASHRAE (IAQ guideline)		**PEL 8 hour average**
Relative Humidity					
Average 11/14/00 – 11/15/00	39.9%		30-50%		None
Range 11/4/00 – 11/25/00	28.7 – 53.9%		30-50%		None
			ASHRAE (IAQ guideline)		**PEL 8 hour average**
Temperature					
Average 11/4/00 – 11/25/00	69 3F		68F to 79 F		To prevent heat stress.
Range 11/4/00 – 11/25/00	61.7 - 76.5 F				

[1] NAAQS is National Ambient Air Quality Standard
[2] PEL is Permissible Exposure Limit
[3] ASHRAE is the American Society of Heating, Refrigeration, and Air Conditioning Engineers

Table 3: Volatile Organic Solvents Found in the 2nd Floor Sleeping Quarters at Station 31.

Compound	Concentration Found (Parts per Million)	Workers Standard Threshold Limit Values: 1999 (Parts per Million)
n-Hexane	0.003	50
Acetone	<0.007	500
Nonane	<0.003	NA
Isopropyl Alcohol	0.014	400
Ethyl Alcohol	0.084	1000
Methylene Chloride	0.063	25
Toluene	0.008	50
Ethyl Benzene	0.001	100
Xylene	0.006	100
d-Limonene	0.003	30 (WEEL)
Trimethylbenzene (1,3,5)	<=0.001	25
Trimethylbenzene (1,3,4)	0.001	25
Petroleum Distillates	0.167	100
Naphtha (Coal Tar)	0.002	300
Total	0.352	NA

Table 4: Concentration of spores measured at Station 31 in the 2nd Floor Sleeping Quarters and outside on the deck off the kitchen.

Spores Sampling Date: 11/14/2000	**Outdoor Level (Outside on deck by the kitchen area)** **(spores/m3)**	In the main area Sleeping area on the 2nd Floor, SE corner of Stn 31. **(spores/m3)**
Alternaria	27	0
Ascospores	107	
Basidiospores	1707	160
Botrytis		
Cladosporium	320	53
Pithomyces		
Epicoccum		
Penicillium/ Aspergillus Types		53
Smuts, Periconia, Myxomycetes	107	
Stachybotrys		
Other		
Total Spores	2,268	319